PHILIPPINE BUREAU OF AGRICULTURE.
DEPARTAMENTO DE AGRICULTURA DE FILIPINAS.

FARMERS' BULLETIN NO. 3.
BOLETIN DE LOS AGRICULTORES NO. 3.

MODERN RICE CULTURE.

EL CULTIVO MODERNO DEL ARROZ.

BY
POR

WILFRED J. BOUDREAU,
RICE CULTURIST.
CULTIVADOR DE ARROZ.

PREPARED UNDER THE DIRECTION OF THE CHIEF OF THE BUREAU.
PREPARADO BAJO LA DIRECCION DEL JEFE DEL DEPARTAMENTO.

MANILA:
BUREAU OF PUBLIC PRINTING.
1903.

2212

CONTENTS.

ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

MANILA, P. I., *August 15, 1902.*

SIR: I have the honor to transmit herewith for publication as a bulletin of this Bureau a manuscript on modern methods of rice culture.

Rice as an article of food occupies the same position in the Philippines that wheat does in America and Europe, and it is eminently proper, therefore, that its culture should receive considerable attention from this Bureau. Especially is this the case when we take into consideration the fact that 375,784,891 pounds are annually imported into these Islands, representing an aggregate of $4,178,912 gold, and that this sum of money could easily be kept in this country for its industrial development if rational, up-to-date systems of rice culture were introduced.

Respectfully,

WILFRED J. BOUDREAU,
In Charge of Rice and Cane Investigations.

F. LAMSON-SCRIBNER,
Chief of Bureau of Agriculture.

MODERN METHODS IN RICE CULTURE.

INTRODUCTION.

The cultivation of rice in the Philippines is in many respects similar to that practiced in China, Japan, India, and other oriental countries. It is true that plows are more generally used here than in these latter countries, but they are such primitive affairs and the work performed with them is so unsatisfactory that, economically considered, they are of very little more value than the mattock and the spade. The main operations, however, such as preparing the seed beds, transplanting, puddling the soil, and harvesting the crop all conform to the oriental type and are such as characterize all countries where labor is cheap.

So cheap is labor in some of these countries that a man's wages for one year are $15 gold and board. Consequently a farmer has very little inducement to invest money in labor-saving machinery, and it is questionable whether it would be advisable, or even practicable, to make a radical change in the rice culture of China and Japan. Most of the lands suitable for rice growing are already utilized for that purpose, and so dense are the populations that it would be next to impossible in these countries to produce sufficient food to maintain the present inhabitants and the necessary draft animals if modern farm machinery were introduced. Besides, the use of labor-saving machinery would result in throwing a large portion of the people out of employment and thus entail widespread suffering and hardship. In addition to this it may be said that the fields are not properly laid out for the use of modern agricultural implements. The majority of the fields are small, irregular strips of land, divided from one another by levees which have been constructed at great cost of time and labor, and before gang plows, disk choppers, and twine binders could be introduced it would be necessary to throw these levees down.

In the Philippines no such obstacles exist. The population is comparatively sparse. In a territory equal in extent to the whole of New England and the State of New York there are only some six or eight million people. The consumption of rice greatly exceeds the produc-

tion, notwithstanding the fact that there are extensive areas distributed throughout the Archipelago which are admirably adapted to the growing of rice. Indeed, the natural conditions for the production of this crop are so favorable that it would not be surprising to see the Philippines become, within the next ten years, one of the leading rice-producing countries of the world.

It was stated above that no obstacles exist to the introduction of a new system of rice culture in this country. We may go further and say that it is absolutely necessary that it should be done. Ever since the occupation of these Islands by the American Army four years ago the price of labor has steadily increased, and as American customs are gradually introduced we may look forward to a further advance. It is needless to say that every industry will be profoundly affected by this, and the rice industry will be one of the first to feel its influence, for it is a crop which must be grown cheaply in order to be profitable. To pursue the same system of cultivation as in China, however, and to have to pay three and four times as much for labor is out of the question. Hence, the rice farmer will have to adapt himself to the new condition if he wishes to compete successfully with foreign rice, and it is with the view of outlining a new system that this bulletin is published.

Of course it will take time before the methods indicated can be carried out in the remote provinces. There are difficulties to be overcome, chief among which is the question of draft animals, but that a revolution in rice culture is inevitable there can be no doubt, and the sooner it is realized the sooner a beginning will be made.

In concluding these preliminary remarks, a few words might be said with advantage in regard to cheap labor and labor-saving machinery. Cheap labor is by no means the cheapest article on the market. In support of this statement the following figures are submitted: The labor of a Filipino in the rice fields of the Philippines has been estimated at $20 gold and board per annum. The amount of land which he can cultivate is 2½ acres, yielding 1,500 pounds of paddy. In Texas or Louisiana, on the other hand, a laborer receives $200 gold and board, but he cultivates 80 acres of land, and the cultivation is so superior that with irrigation water alone he produces 160,000 pounds of paddy. In short he receives ten times the wages, but he produces one hundred times more rice than the Filipino laborer.

It is not claimed that such results can be obtained in the Philippines. This is a question which can only be definitely settled in the field, and as soon as possible practical work will be undertaken to determine exactly to what extent local conditions may modify the results obtained in Louisiana and Texas.

SOILS SUITABLE FOR RICE GROWING.

Any fairly fertile soil that has sufficient clay to retain the moisture will grow rice. Generally speaking, lands which will produce cane, cotton, and corn will produce rice, and, where a system or rotation is followed in the cultivation of these crops, rice can be made a part of the system with advantage. It does not follow, however, that cotton, cane, or corn will grow well where rice will thrive. On the contrary, the best rice lands are those which have an impervious substratum of clay, and, ordinarily, such lands are not very well adapted to sugar, corn, and cotton culture.

In selecting a site for a rice farm—we shall speak of lowland rice only for the present—rolling lands should be avoided, as it is impossible to flood such lands economically. The greatest expense in the cultivation of rice is the cone connected with the construction of levees, and the amount of leveeing depends altogether upon the topography of the country. Perfectly level land presents ideal conditions for rice culture, because the "cuts" may be made as extensive as one may desire, the limit being the amount which can be planted in two or three days. A larger field would be impracticable, because the rice would not all germinate at the same time. The advantages of large cuts over small ones can not be exaggerated. Not only is the expense of leveeing very much reduced, but the amount of unoccupied land is not so great, and there is not so much likelihood of the fields becoming infested with weeds, as these levees are veritable weed nurseries. Furthermore, if the nature of the soil permits, twine binders can be more profitably employed than in small cuts.

When the land slopes, on the other hand, the size of cuts depends altogether upon the grade. Rice will not thrive well in more than 8 or 10 inches of water, and if the land has a slope of, let us say, 3 inches to the acre, it will be necessary to construct the levees every 2 acres, since 4 inches of water on the elevated end of the field will flood the rice to a depth of 10 inches at the lower end. Therefore, the more the land slopes the nearer the levees have to be, and finally a limit is reached when gang plows and other implements can not be used, as every turn at the end of the cut represents a loss of time and money.

There are two other factors which should be considered in selecting a site for a rice farm, and these are irrigation and drainage. No one can undertake the cultivation of rice and afford to ignore them, and they are of such primary importance that they will be discussed under a separate heading.

PREPARATION OF THE SOIL.

The breaking of the land should begin as long before planting as possible, for, inasmuch as water remains on the soil during the whole period of growth of the rice crop, the microörganisms which are responsible for nitrification whereby soluble nitrates are provided for the plant remain dormant, if they be not totally destroyed for lack of oxygen, and for this reason the land should be plowed as soon as possible after the first crop is gathered, in order to give the soil a thorough airing.

The breaking up of the soil can be effected with any ordinary steel

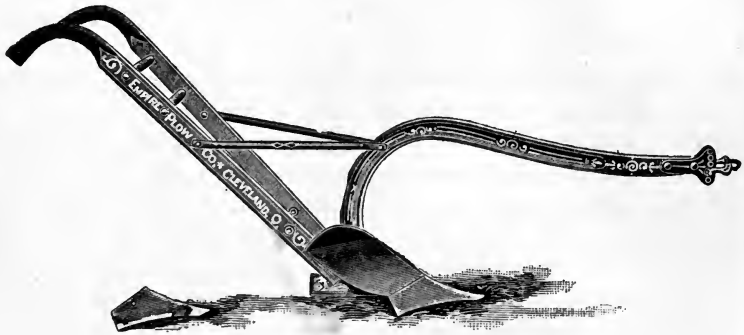

FIG. 1.—A light steel beam plow.

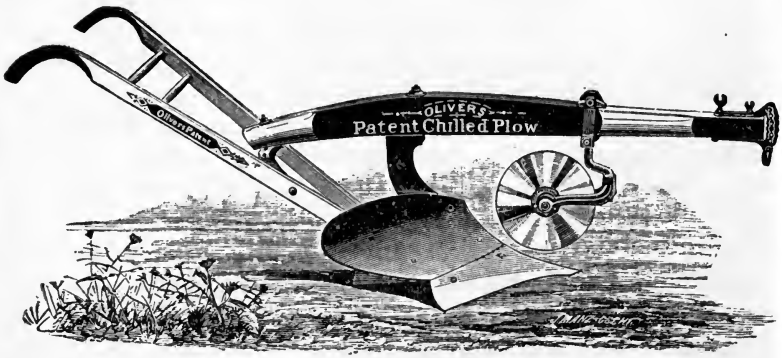

FIG. 2.—A heavy wooden beam plow.

plow (figs. 1 and 2), but where it is desired to grow rice on a large scale gang plows are more economical (figs. 3 and 4). There are different makes of these implements, but they are all constructed on the same principle and consist essentially of a broad plow or a number of smaller ones hung on a frame and wheels. With one of these and three or four mules a man can do five and six times the work in one day that he could do with an ordinary plow, and three gang plows are all that are needed to plow up a 500-acre farm.

The depth to which the soil should be plowed depends upon local conditions, and no general rule can be given that would be applicable to every case. For some soils, plowing 5 or 6 inches deep gives the best results, whereas, in other cases, 3 or 4 inches are reported to give as

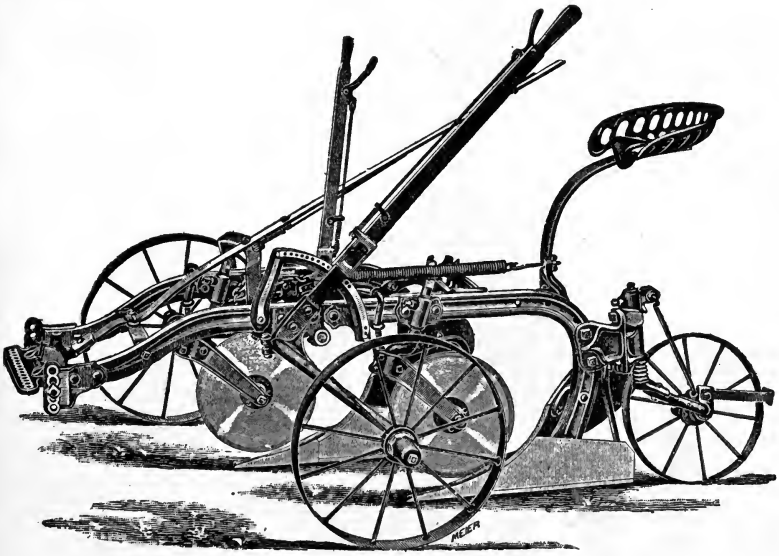

FIG. 3.—A two-furrow gang plow.

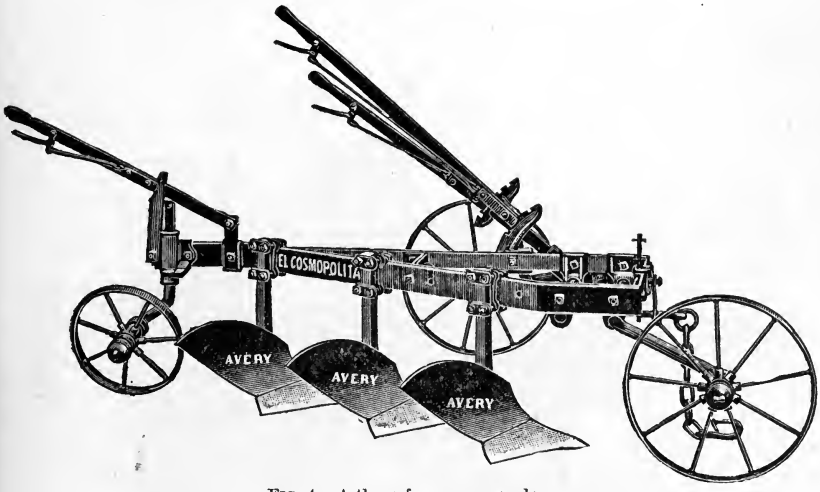

FIG. 4.—A three-furrow gang plow.

satisfactory crops as deep plowing. In all old rice fields, however, the probabilities are that an artificial hardpan exists as a result of the shallow plowing which is practiced, and in such cases the land should be plowed deeply the first year, so as to permit of better under drainage, and in

order that the roots of the plant may penetrate the soil more deeply in quest of foot.

After the land is broken up it should be pulverized with a disk chopper and smoothing harrow to prevent the land from baking and to put it in

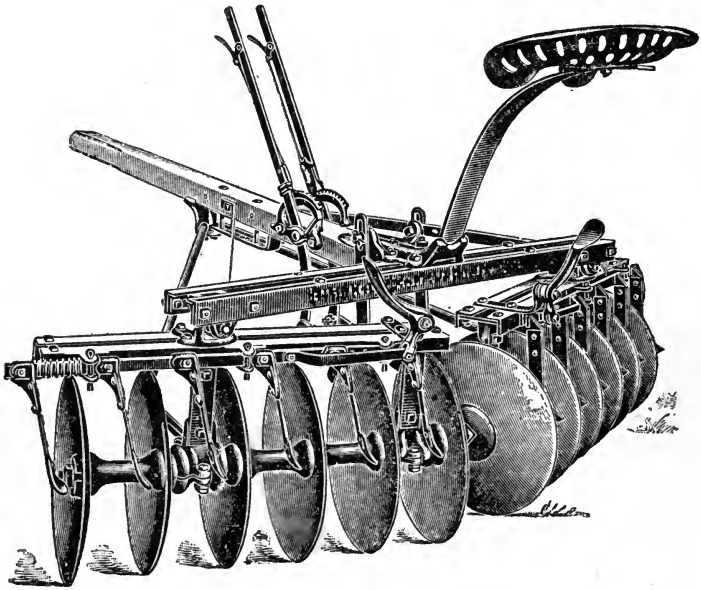

FIG. 5.—A disc harrow.

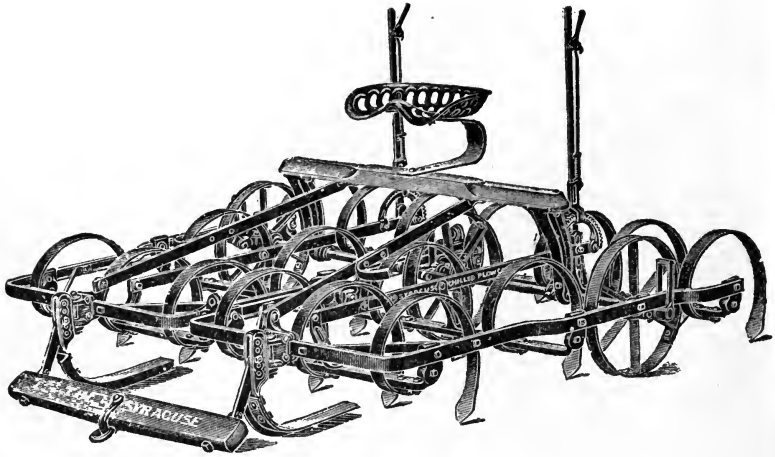

FIG. 6.—A spring-tooth harrow.

such a condition that it will retain moisture. If the land is not too heavy the disk chopper will not be necessary, any heavy harrow being sufficient. (Figs. 5, 6, and 7.)

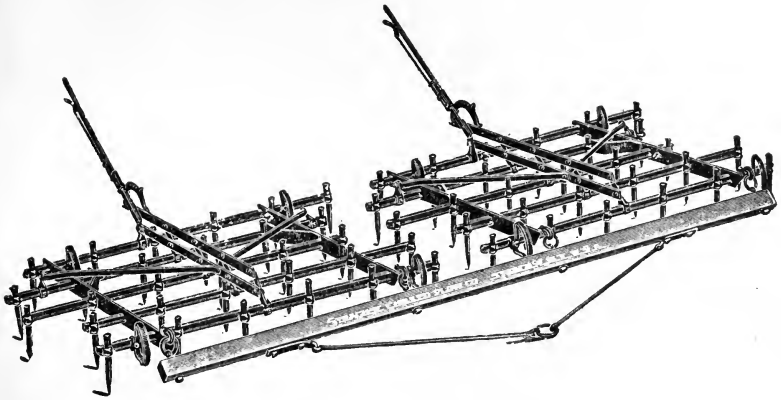

FIG. 7.—A smoothing harrow.

PLANTING.

There are two ways in which rice may be planted. It may either be sown broadcast, or it may be planted with a drill. Both methods are extensively used, but the best authorities advocate the use of the drill. Rice planted with the drill, it is claimed, will germinate more uniformly, and this is an important point in the cultivation of rice. Besides, when the land is grassy it is an easy matter to hoe and weed the rice if it has been drilled, whereas, if it were sown broadcast, the operations would be very much more difficult. (Fig. 8.)

The seed may be sown to the depth of 2 inches in May and June, and at the rate of 2 bushels to the acre. When the soil is very dry a roller should

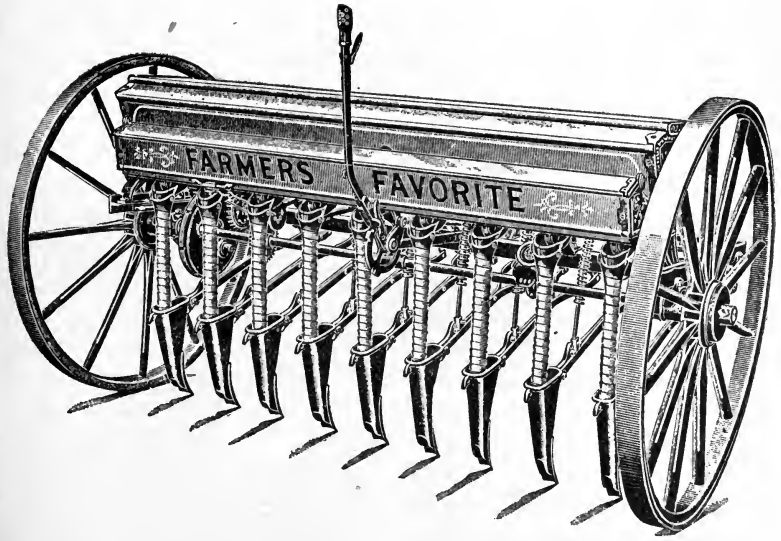

FIG. 8.—A rice drill.

be dragged over the field so as to compact the ground, thereby increasing the capillary power of the soil and thus causing moisture to rise from below. Should water be available, however, a better plan is to apply a sufficient quantity of it to saturate the soil and to pass a light harrow over the field as soon as it is sufficiently dry.

DRAINAGE.

Although rice is a water plant, good drainage is as essential in its cultivation as it is in that of any other crop. If the land will not admit of thorough drainage, it will be impossible to prepare the ground properly, and in consequence the stand will be poor and the yield of the crop very much diminished. It is generally believed, too, that when rice approaches maturity the water should be withdrawn from the land so as to permit of the formation of a good heavy head. Rice can unquestionably ripen in water, but the character of the seed is very much affected for the worse thereby, and in milling such a crop it will not give as good an article of commerce as it would have given if the water had been withdrawn at the proper time.

It is in the harvesting of the crop, however, that drainage is most important. It matters not whether the rice is harvested with a reaper and binder or a sickle, the field should be dry, so as to permit of the shocking of the rice in the field where it falls. So far as shocking rice in mud and water is concerned, that is absolutely out of the question, and to have to carry it to the levees, as is now done, is too slow and expensive a process.

IRRIGATION.

Of equal importance with drainage is the subject of irrigation. Unfortunately, the conditions are so favorable for the growth of rice during the rainy season that very little has been done to utilize the water supplied by the large number of streams which traverse the country in every direction. Usually the rain water is sufficient to mature one crop, and the river water, which contains a large amount of silt and soluble plant food, has been permitted to flow uninterrupted to the sea.

The western farmer and the sugar planter of the Hawaiian Islands know what a difference irrigation makes in the yield of their crops, but such results are not as remarkable as those that are obtained in applying irrigation water to rice lands. In certain portions of Louisiana and Texas rice has been grown on some lands for a number of years, and they continue to yield nearly as much rice now as they did the first year they were cultivated, although the only fertilizer applied during the whole of this time has been irrigation water. Even here in the Philippines, where the yield of rice per acre is in the neighborhood of 600 pounds, lands have been made to produce 2,000 pounds with the help of irrigation.

We need not go far to find the reason for this. It is a well-recognized fact that no matter how rich in plant food a soil may be, the plant,

unaided, can not assimilate any of it. By a wise provision of nature most of the plant food in the soil is stored in the form of insoluble compounds, and as such they can not be leached out by rain water. Before the rootlets of the plant can absorb this plant food it is necessary that it should be in soluble form, and this chemical operation is performed mostly by low forms of plant life, commonly known as bacteria. As was noted above, however, these special bacteria will thrive only in the presence of oxygen, and as rice lands are under water for a great part of the time the work of the bacteria is suspended, and consequently the supply of soluble food in the soil ceases to increase under these conditions, and, unless the young plant is supplied with food from some other source, it can not be expected to reach perfection.

Irrigation supplies this extraneous food, and although there may be but little fertilizers in the water, such an immense quantity of water is evaporated during the growth of the rice that a large amount of nitrogen, phosphoric acid, and potash are given up to the plant.

Another reason why irrigation should be employed in preference to rain water is because its temperature more nearly approaches that of the ground than does the temperature of rain water, and this is a point recognized to be of a good deal of importance.

Finally, by means of irrigation water two crops of rice could be grown on the same land in the course of a year and the yield of the land thereby doubled.

DITCHES AND LEVEES.

The most economical way of digging ditches and constructing levees is to make use of good strong plows, scoops, and grading machines (fig. 9). With a plow, a scoop, and a pair of mules a man can do as much work in a day as he could do in two weeks with a spade. Where the operations are to be conducted on a large scale and the planter can afford to purchase a

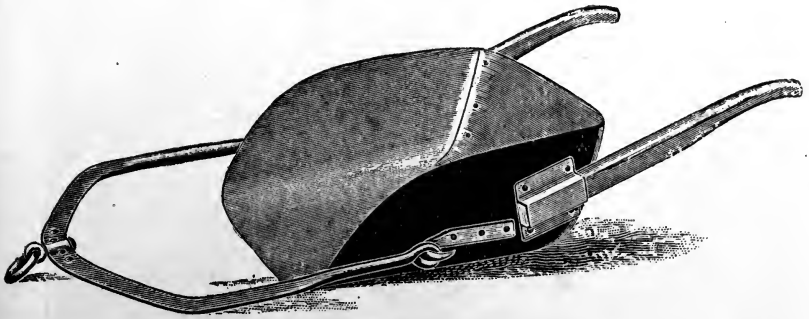

FIG. 9.—An ordinary scoop or road scraper.

road machine, it would be well for him to do so, as it is very useful in making the main channel or canal for conducting the water from the water supply to the field.

In building the levees around the different cuts the aim should be to

for this is that the former levees facilitate the use of agricultural implements.

A good plan is to plow a ridge 6 or 8 feet wide, where the levee is to

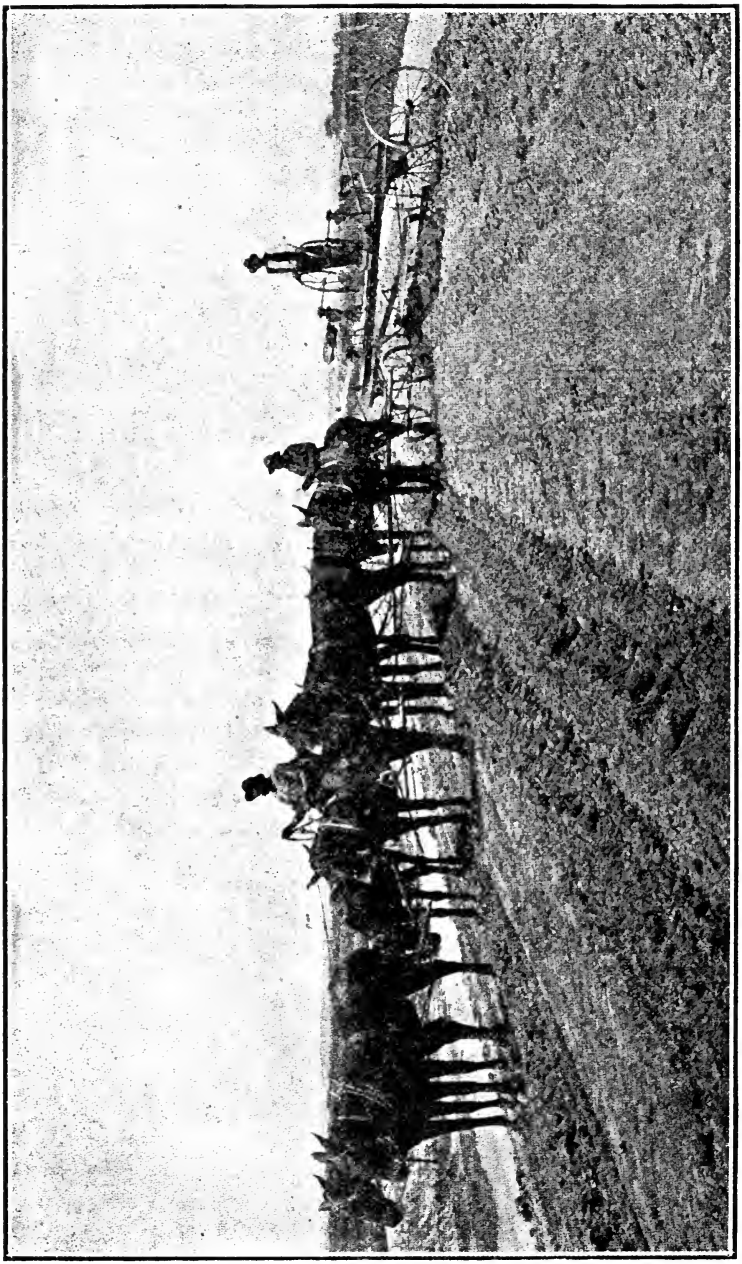

FIG. 10.—Road scraper in operation.

stand, and harrow down. As soon as it rains, plow up again, always throwing the dirt to the center, and continue this process until the bank has attained a sufficient height, usually 18 to 20 inches.

The question of utilizing the water supply, constructing reservoirs, dams, lifting water from rivers, etc., is too large a one for present dicussion, and it will be made the subject of future bulletins.

TREATMENT OF THE CROP.

Should no irrigation water be available, as soon as the rice is 4 or 5 inches tall all the drains in the levees are to be closed so as to retain the rain water, and if the season is favorable sufficient water will be caught to keep the grass smothered and to mature the rice. In no case should the water completely cover the rice.

Where irrigation is practiced, enough water to saturate the soil may be applied when the rice is 2 or 3 inches tall, provided it stands in need of it. This will give the crop an early start, and this is important, for in the struggle for existence with the grass, rapid growth in the rice is all important.

In the course of three or four weeks the rice will be 7or 8 inches tall, and water may be turned on to the depth of 4 inches. As the rice grows more water should be added until it stands about 8 inches deep.

When possible, it is well to keep the water in circulation, as it prevents the growth of certain grasses which thrive in stagnant water. This can be done by permitting a certain amount of water to escape at the lower end of the field and supplying a corresponding amount at the upper end.

Ordinarily no further attention is necessary until the crop is ready to be harvested, but should weeds spring up among the rice plants they will have to be pulled, and occasionally the rice becomes so grassy that all growth ceases and the plant assumes a yellow color. In such a case there are only two remedies; either more water must be admitted so as to completely submerge the grass, or, if the rice is too small to permit of such a treatment, the water must be completely withdrawn and the field mowed down. The rice, by virtue of the rapidity with which it grows, when mown down will soon outstrip the grass, and by flooding at the proper time the crop can be saved.

There should very seldom be an occasion for such heroic treatment, however, on a plantation which has sufficient irrigation water, because, with a proper system of control, the grass can nearly always be completely covered with water and thus smothered out.

Within ten or twelve days before the grain is ripe the water should be completely drained off. The time to draw off the water can be easily ascertained by noticing the color and position of the heads and the consistence of the grain. As the rice begins to ripen the heads assume a drooping position and they take on a pale straw color. As above noted, the grain, too, is a good guide, for on breaking it it will be found to be of the consistency of dough.

HARVESTING.

The harvesting of the rice crop is an operation which can be performed either with the sickle, the cradle or the reaper, and binder (figs. 11, 12, and 13). Whenever it is possible to use a reaper and binder one of the

FIG. 11.—Rice sickle.

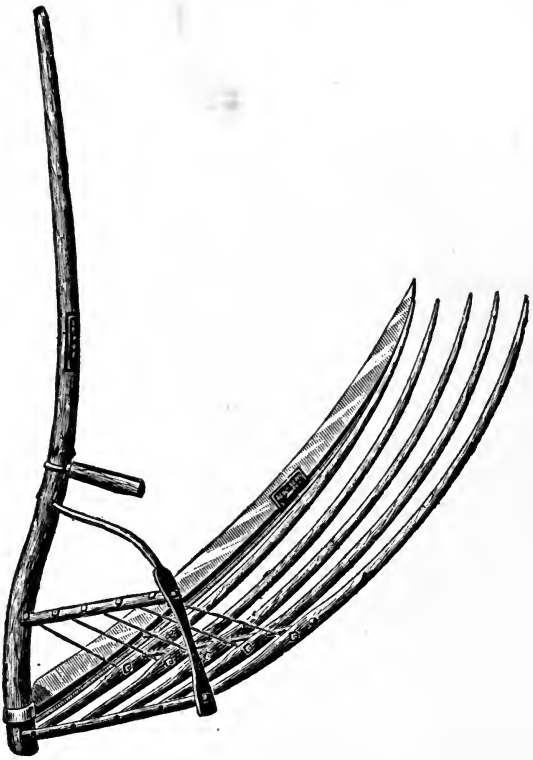

FIG. 12.—Cradle for harvesting rice or other grain.

greatest expenses in rice growing is reduced to a minimum. With the use of this machine and six mules a man can reap from 8 to 12 acres a day. Unfortunately it is not every field which can be reaped with a twine

binder, and its use on any given tract of land is determined by three conditions: First, the land must be susceptible of thorough drainage; next, an impervious substratum of clay must underlay the land; and, finally, the harvesting season must be moderately dry. Without these three conditions the twine binder is impracticable. The machine is a

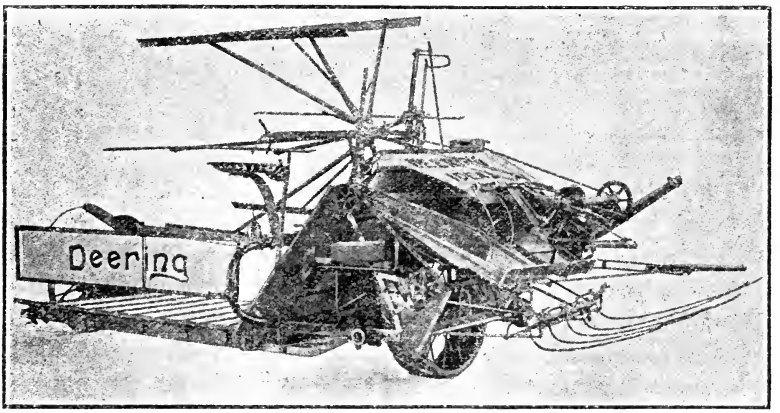

FIG. 13.—Reaper and binder for harvesting rice.

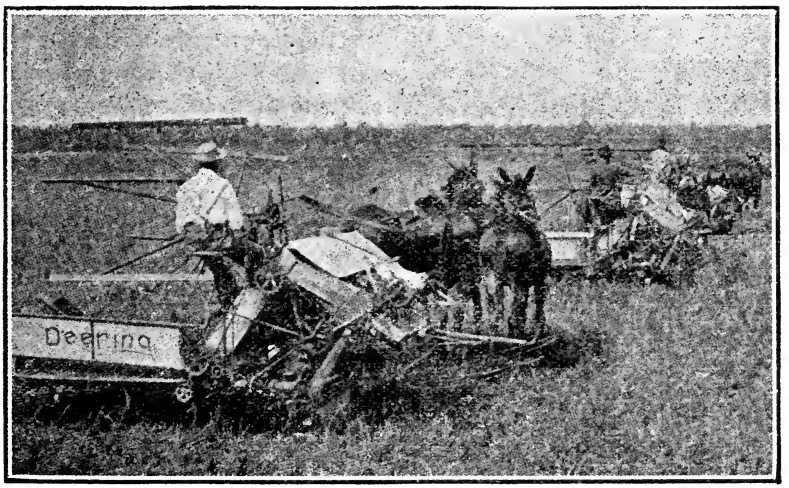

FIG. 14.—Harvesting rice in Louisiana.

heavy one, and unless the ground is dry it will sink so deeply as to be very heavy to pull. In addition to this the drive wheel becomes so clogged with mud and bits of straw that it slides along the ground instead of turning, and, in consequence, the knives are stopped.

Whether the physical condition of the soil will permit of the general

introduction of this valuable machine in the rice fields of the Philippines is an unsettled question. The Bureau has a reaper and binder among its collection of agricultural machinery, and a thorough test of its efficiency will be made as soon as practicable.

Where it is not possible to make use of the twine binder, sickles and cradles are employed, the rice being cut with about 2 feet of straw and tied in bundles about 6 inches in diameter. Some 25 or 30 of these bundles are shocked together and a few bundles placed on top of the shocks to protect the grain from too much sun and from the depredations of birds.

THRESHING.

The machines employed in threshing rice are practically the same as those used in the wheat fields of the western United States. Their capacities range from 40,000 to 90,000 pounds of paddy per day, and it can readily be seen that a small farmer does not stand in need of a thresher for his exclusive use. Not only this, but in the United States the cost of a threshing machine including engine is $1,200 gold, and it is only persons of some means, even in America, who can purchase them. (Fig. 15.)

In order to overcome this difficulty it is customary for some person to buy a machine and charge the farmers so much per sack for threshing their rice. The threshers are portable and are hauled from place to place by the traction engines, which furnish the power for operating the threshers. (Fig. 15.) In case a farmer has only fifty or a hundred sacks, however, he has to haul the rice in the straw to the machine, because it is not profitable to move the thresher unless it can do a day's work in one place.

Rice threshing is a very profitable business in the United States. As much as $75 net per day is earned by some threshers, and although the rice industry may not have recovered sufficiently from the recent troubles to warant their introduction in the provinces just now, we can see no reason why threshers situated at central points should not prove profitable in the near future.

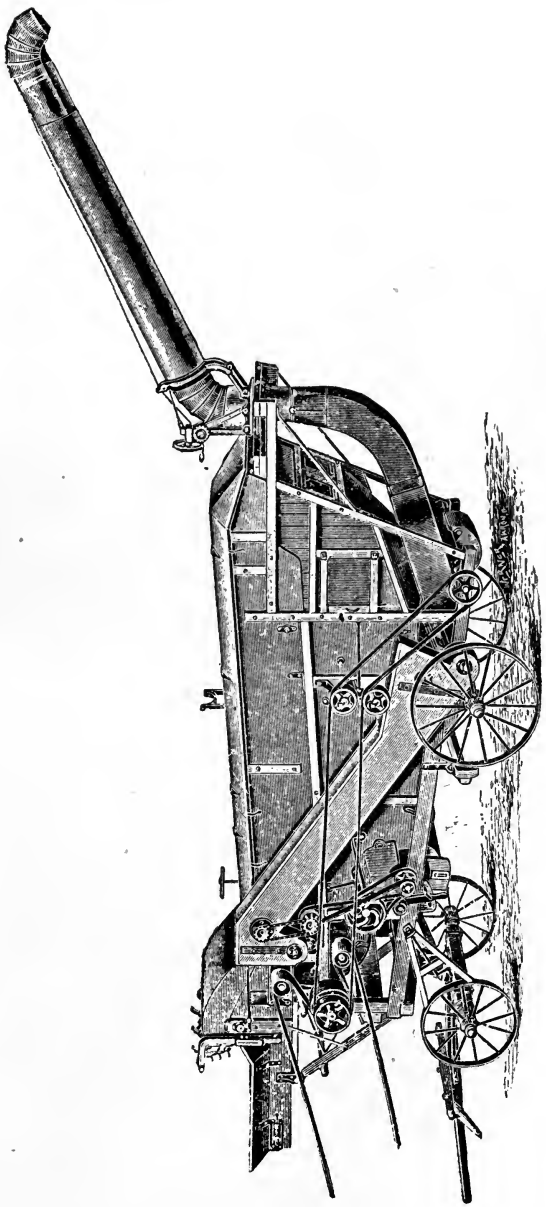

FIG. 15.—Thresher.

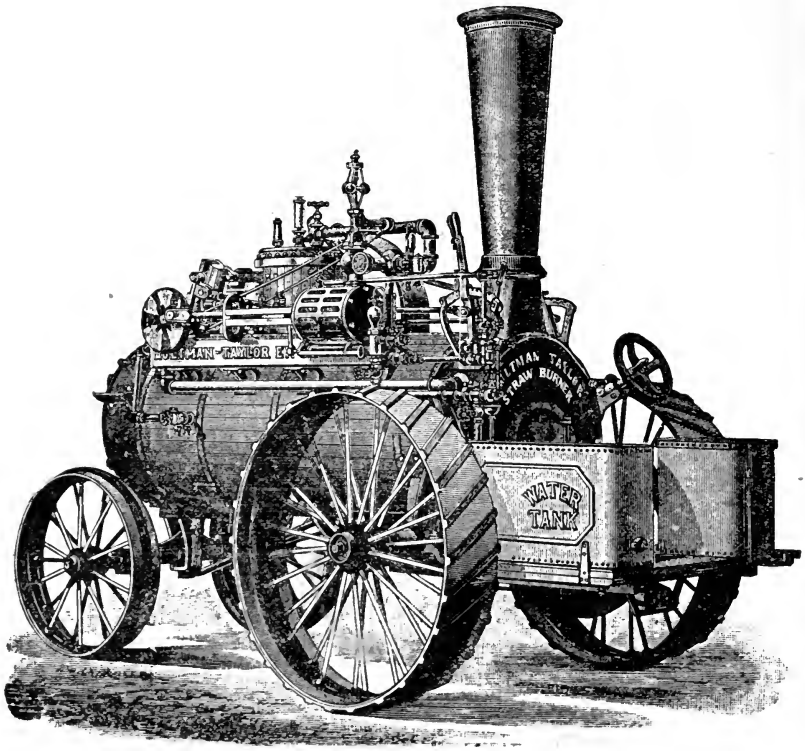

FIG. 16.—Traction engine.

FERTILIZERS.

In determining the kind of fertilizers and the quantity which should be applied to a soil in order to grow any given crop, one of the most essential things to know is the composition of the plant, for by knowing this we get a good idea of the fertilizing materials which the crop extracts from the soil, and thus we are able to supply this drain judiciously.

The average analysis of the rice plant shows that every 100 pounds of the grain contains 1.19 pounds of nitrogen, 0.321 pound of phosphoric acid, and 0.16 pound of potash; and 100 pounds of the straw contains 0.756 pound of nitrogen, 0.26 pound of phosphoric acid, and 0.42 pound of potash. Therefore, an acre of land which produces 2,000 pounds of paddy and 4,000 pounds of straw will lose a total of:

	Nitrogen.	Phosphoric acid.	Potash.
2,000 pounds paddy	23.80	6.42	3.20
4,000 pounds straw	30.24	10.40	16.80
Total	54.04	16.82	20.00

With these figures we should be able to form a fair estimate of the amount of fertilizer to apply to rice land. But from this a deduction in the amount of nitrogen to be applied may be made for the nitrogen which is brought to the soil in rain water, and where irrigation is practiced a deduction may be made not only in the amount of nitrogen but also in the phosphoric acid and potash. What this amount is it will be impossible to say until chemical analyses are made of the waters of the principal rivers and streams of these Islands, and it is to be hoped that data in reference to this matter will be available in the near future.

Just in what form to apply fertilizers to rice lands is another question to be considered. Rice is so peculiar in its habits of growth that the matter of fertilizing it is very much more complicated than is the case of ordinary crops. As was noted above, nitrification is an impossibility in a field of growing rice which is under water; consequently, the application of any but soluble fertilizers will give no immediate results, and such soluble fertilizers as sodium nitrate and water soluble phosphates are so high priced that it is questionable whether they will ever be extensively used. The only practical scheme that can be suggested just now is that the land be fertilized and fallowed, or that a system of rotation such as is practiced in Java be introduced. By rotating the crop with corn, leguminous plants, cane, and cotton, not only is it possible to fertilize the land and increase the subsequent yield, but noxious weeds can be either totally destroyed, or at least greatly decimated.

VARIETIES.

The number of distinct varieties of rice is variously estimated at from 1,400 to 3,000. Whether there are even so many as 1,400, or whether the same variety bears different names in different localities, is not known. It is very well recognized, nevertheless, that varieties play an important part in the color, shape, size, taste, yield, and maturity of the grain, and too much care and judgment can not be exercised in selecting seed. Many of the good effects of efficient cultivation will be lost if an inferior variety of seed is planted, and there are certain varieties of the rice which are so poorly adapted to the milling process that great financial losses are incurred in cultivating them.

In certain parts of the United States where Honduras rice was formerly exclusively grown this loss was so great that seed rice was imported from Japan with the view of obviating this defect in the Honduras, and the Japanese rice gave such satisfactory results, not only in the greater resisting power which it possessed in withstanding the breakage of the mills, but also in the yield per acre, that larger quantities were imported the following year, and now the Japanese rice is cultivated very extensively.

Some of this Japan rice has lately been imported by the Insular Bureau of Agriculture and is now being distributed to the farmers of the Islands.

UPLAND OR MOUNTAIN RICE.

This rice, as its name implies, is cultivated where the land is too rolling to practice flooding. Large amounts of it are raised in these Islands, and in certain districts where the valleys are narrow and level lands are scarce mountain rice constitutes the principal article of food of the natives.

In regard to its cultivation, very little need be said more than has already been stated in regard to lowland rice. The cultivation and harvesting of the crop are practically the same as for flooded rice, excepting that no provision need be made for leveeing. The only difference between the cultivation of the upland and the lowland rice lies in the fact that the former has to be frequently hoed and weeded, because there is not water on the land to smother the grass.

CONCLUSION.

In conclusion we wish to reiterate that there is no reason why scientific methods of culture and modern agricultural implements should not make the Philippines one of the leading rice countries of the world. It was not many years ago when the rice industry in Louisiana was on the same footing with the rice industry of the Orient, and yet such a revolution has been effected in the cultivation of rice in that State within the last fifteen years as has not been accomplished in Chinese rice culture in six thousand years.

APPENDIX.

IMPLEMENTS AND DRAFT ANIMALS REQUIRED TO CULTIVATE A 500-ACRE FARM.

For the information of those readers of this bulletin who may be interested in the matter, the following statement relative to the number of draft animals and kind of machinery required to cultivate a 500-acre rice farm, together with the cost thereof, in United States currency, is appended:

20 mules	$3,000.00
3 twelve-inch gang plows	135.00
3 disc harrows	60.00
3 smoothing harrows	45.00
3 twine binders for harvesting	450.00
1 thresher and traction engine	1,250.00
Total	4,940.00

The thresher can be made to thresh the rice of 1,000 or 1,500 acres; so that, if anyone should wish to cultivate that amount of land, it would only be necessary to purchase 40 or 60 mules, and the proper multiple of machinery stated for a 500-acre farm, exclusive of thresher.

The gross receipts for the crop of a 500-acre farm will vary in the United States from $15,000 to $20,000 gold, according to the amount of red rice found in the paddy.